Efficient Quantification of Uncertainties in Complex Computer Code Results, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

Propagation of parameter uncertainties through large computer models can be very resource intensive. Frameworks and tools for uncertainty quantification are generally geared to individual codes, are research codes, or are single-purpose tools such as LHS matrix generators. The Reduced-Order-Clustering-Uncertainty-Quantification (ROCUQ) methodology discussed in this proposal is specifically designed to circumvent many of the issues associated with uncertainty quantification of large simulation codes. The ROCUQ methodology has been applied in several different physical disciplines with good results. The computational methodology is a combination of reduced-order modeling, stratified sampling (Latin Hypercube Sampling ⇔ LHS), statistical clustering of results (K-means clustering) and a few (five to ten) full-physics runs of the high-fidelity model under investigation. The method should be applicable to hundreds of uncertain variables when required. ROCUQ enables estimates of system response quantities (SRQ) uncertainty distributions for situations where it is not feasible to use purely sampling, collocation, or other techniques where many runs would be required. For some organizations, uncertainty analysis has never been possible due to resource limitations, and thus is not part of the organizational culture. Many analysts know that uncertainties can be important, but have no way to expend sufficient resources (money, CPU cycles, time) to do the work needed to quantify uncertainties. A methodology such as ROCUQ promises to open doors in organizations that know that they have the need, and may now be able to actually perform the analyses. Successful completion of the Phase II project will produce not only new software that will be able to be used by researchers and industry, but will assemble insights on the use of reduced order models in a variety of disciplines, and provide guidance and rules for the use of ROCUQ for the estimation of SRQ uncertainty distributions.

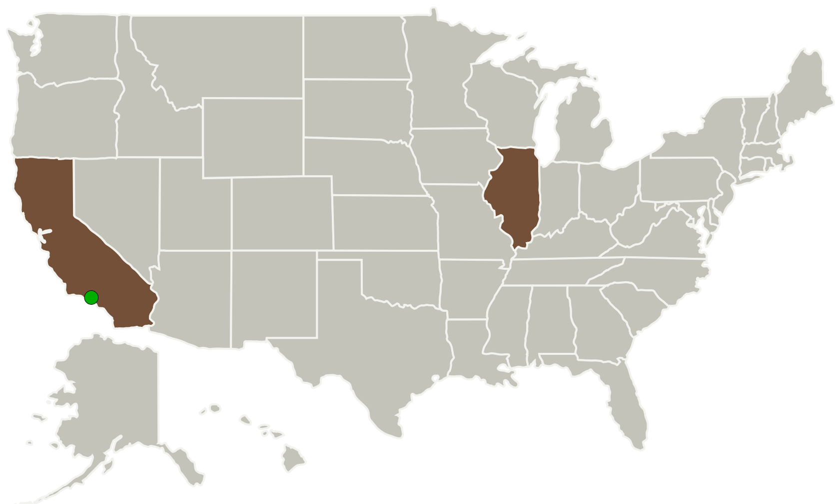
Efficient Quantification of Uncertainties in Complex Computer Code Results, Phase II

Table of Contents

Efficient Quantification of Uncertainties in Complex Computer Code Results, Phase II

Completed Technology Project (2011 - 2013)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
IllinoisRocstar, LLC	Lead Organization	Industry	Champaign, Illinois
Board of Trustees of the University of Illinois	Supporting Organization	Academia	Champaign, Illinois
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Illinois

Project Transitions

July 2011: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

IllinoisRocstar, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

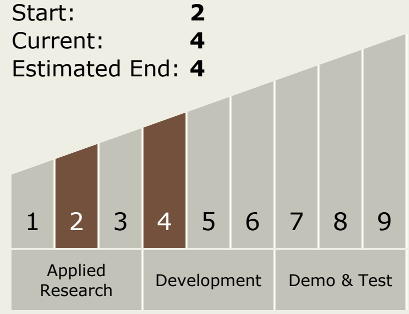
Carlos Torrez

Principal Investigator:

Mark D Brandyberry

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



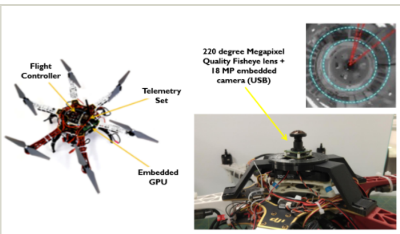
Efficient Quantification of Uncertainties in Complex Computer Code Results, Phase II

Completed Technology Project (2011 - 2013)

June 2013: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/140352)*

Images



Final Summary Chart Image
Efficient Quantification of Uncertainties in Complex Computer Code Results, Phase II Project Image
(https://techport.nasa.gov/image/129116)

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └ TX09.4 Vehicle Systems
    └ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System